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ARS SPECIAL REPORT

SCRAPIE

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Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE

SCRAPIE is a disease affecting the nervous system of sheep and goats. It has appeared sporadically in the United States since 1947, in 61 flocks in 19 States. The disease is particularly difficult to eradicate because of its incubation period of 18 to 42 months.

A cooperative State-Federal eradication program has been in operation since 1952. Under this program, infected and exposed sheep are slaughtered and possibly exposed flocks are kept under surveillance for the length of time necessary, considering the possible 42-month period of incubation. The number of flocks on inspection schedules stands at about 1,700.

External symptoms of scrapie are well known. Considerable research has been done abroad and knowledge of the disease has been accumulated by experience with it. But further research is needed to establish such basic knowledge as the exact nature of the organism that causes the disease, devise tests to locate early infection, and test effective disinfectants to use on infected premises.

Information in this report was furnished by the Animal Disease Eradication Division and the Animal Disease and Parasite Research Division, Agricultural Research Service

SCRAPIE

SCRAPIE is a chronic infectious disease of sheep and goats, which was first diagnosed in the United States in 1947. An active cooperative program of eradication was started in 1952. Scrapie is exceptionally hard to combat because of its long period of incubation--1-1/2 to 3-1/2 years or more--which makes it difficult to determine when and whether the disease has been eradicated. The situation is further complicated by a lively trade among purebred sheep growers, who sell their animals widely from State to State and within States.

The outward or clinical symptoms of scrapie are well known. Its best-known symptom is the rubbing and scraping the animals do because of furious itching. As the disease progresses, there is lack of coordination, prostration, and death. No effective treatment is known and no vaccine has been devised. The disease does not affect human beings. Since it first appeared in the United States scrapie has been found in 61 flocks located in 52 counties of 19 States (fig. 1).

The eradication program provides for slaughter and indemnity payment for infected and exposed sheep and maintaining others under surveillance. The number of flocks thus kept under supervision increased from

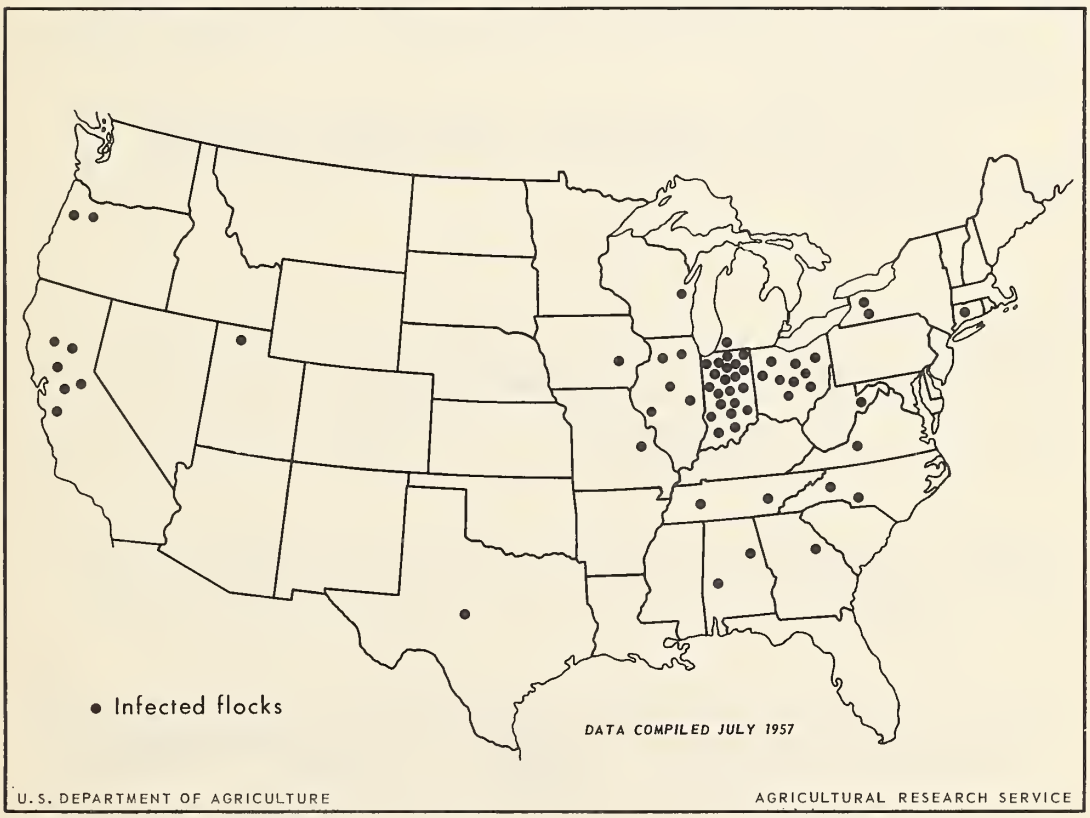

Figure 1.--Cases of scrapie reported in the United States, April 1947-July 1957.

more than 700 at the end of 1954 to 1,665 at the end of 1955, reached more than 2,000 in November 1956, and has since declined to about 1,700 (fig. 2). These flocks contain more than 300,000 animals.

ERADICATION PROGRAM

THE eradication program is based upon plans long used for stamping out other diseases, with modifications to fit the demands of this specific ailment. The program has been adopted after consultation with regulatory and research officials and representatives of the sheep industry.

Prompt reporting of cases resembling scrapie is stressed, along with widespread dissemination of information about the disease to all interested parties.

Field diagnosis is confirmed by laboratory studies.

Disposal is effected by two methods: Infected animals are slaughtered and their carcasses are buried or burned. Exposed animals are moved for immediate slaughter to authorized plants provided their identity is maintained and their slaughter confirmed. Facilities and conveyances used by infected and exposed animals are cleaned and disinfected.

Indemnity for animals disposed of is paid in accordance with State and Federal regulations. Federal indemnity, "not to exceed 50 percent of the

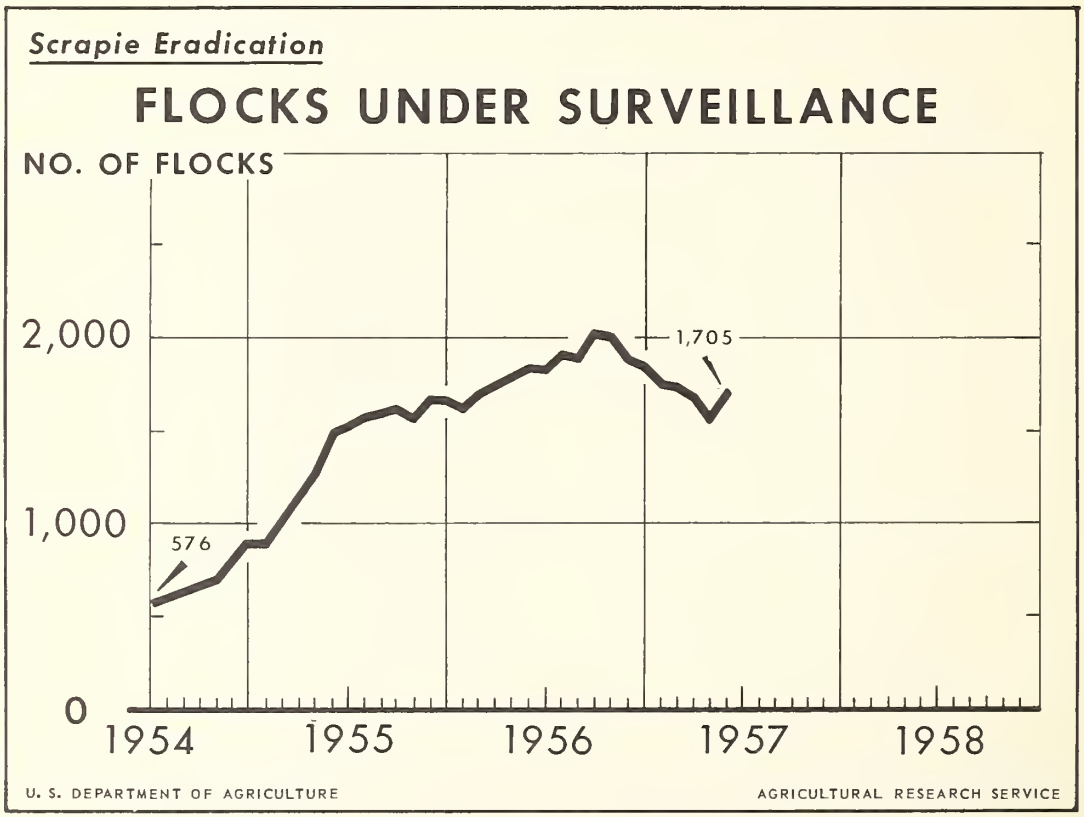

Figure 2.--Flocks maintained under supervision to check the spread of scrapie in the United States, 1954-57.

difference between the appraised value of each animal so destroyed and the net salvage received by the owner," is limited to $25 a head for grade animals and $75 a head for purebred animals. The Federal share of the indemnity may be paid to owners without waiting for the State involved to pay its share. The regulations require that animals be slaughtered within 15 days after appraisal, permit animals that have been exposed but show no symptoms to be slaughtered for meat, and withhold payment of indemnity until after premises and vehicles have been cleaned and disinfected.

This indemnity arrangement permits owners of infected animals to be reimbursed to a large extent for their losses in animals, although additional losses in business and trade may not be reimbursed. Both Federal and State indemnities have been paid for the majority of infected and exposed flocks, totaling more than 30,000 animals.

Infected flocks are quarantined and slaughtered, the premises are cleaned and disinfected, and restocking is not permitted until at least 90 days after disinfection.

Exposed flocks are quarantined, all animals and their progeny that may have been exposed in the past 42 months are slaughtered, the premises are cleaned and disinfected, and the flocks are inspected at least every 6 months for 42 months from the time the exposed animals were removed.

Flocks not exposed for 42 months may be inspected once and dropped from inspection, or they may be put on regular inspection schedule, if warranted.

Origin-of-infection flocks are treated the same as infected flocks.

Other flocks may be kept under supervision when the situation warrants.

THE DISEASE

IT IS ASSUMED that scrapie is caused by a filtrable virus. Within the past 2 or 3 years, however, those doing research on the disease have had some doubts as to the exact nature of the causative organism. A leader in Canadian research has said candidly that he does not know what it is. Researchers in Great Britain say that the organism has many of the attributes of a true animal virus, but they are not yet certain. One reason for doubt is

Its high resistance to agents that normally kill viruses--it survives hours of boiling without destruction and is resistant to a 1-percent solution of chloroform, to 2-percent phenol, to 2-percent phenol ether, and to 3-percent formalin.

Such resistance to virucidal agents is not compatible with what is known about other viruses. Like some viruses, however, it survives a long time under freezing conditions. After being held at a temperature of —60° C. [—140° F.] for 2 years, infected brain tissue still causes the disease.

Symptoms.--The indications of scrapie may vary considerably from one case to another. Those presented here are a composite of symptoms observed by State and Federal veterinarians in 19 States. The disease has appeared between the known extremes of 3 and 43 months after last known

natural exposure. Most of the animals showed symptoms 10 to 33 months after last known natural exposure. Only 1 showed symptoms more than 42 months after exposure. When sheep and goats are inoculated by injection directly into the brain for experimental purposes, the incubation period is 4 to 22 months.

Because of its long incubation period, scrapie is seldom seen in sheep under 18 months of age. Only one of this age has been found with scrapie in the United States from 1947 to 1957. In the American experience, most of the animals contracting the disease were from 2-1/2 to 4 years old, several were 5-1/2 to 6 years old, and one was 8 years old.

In the early stages of the disease the animal is nervous and apprehensive. There may be slight tremors of the head and neck and rapid muscular tremors of the thighs and flanks. Often one of the early signs is loss of weight in spite of continued good appetite. There is no appreciable rise in temperature. These early symptoms, which may be overlooked, are not constant--they may be present one day and absent the next. Continued observation of suspected animals is required.

In many cases, rubbing is the first sign noticed. This is the outstanding symptom, from which the English name of the disease is derived. Before the disease runs its course, buttocks, flanks, and sides may be scraped free of wool, from scratching against fences, trees, and walls. Two ewes in Indiana rubbed off practically all of their wool. Some sheep rub their heads as well as other parts of the body. The skin where the wool has been rubbed off is normal except for the damage caused by rubbing.

When a person rubs the sheep's back, loins, or thighs, there is usually a characteristic "scratch reflex," manifested by nibbling movements of the lips, licking motions of the tongue; raising, lowering, and turning of the head; wiggling the tail stump; and vigorous movement of skin and fleece in the area of the tailhead. In rare cases the scratch reflex may be absent, as it was in an infected ram and ewe found in California in 1957. An ejaculation reflex was observed in a California ram in 1955 when the animal was rubbed on the back. Animals may bite their lips and legs, causing skin abrasions and bleeding, and some pull out wool with their teeth.

Head and neck are often held in unusual positions, the ears droop, lips and facial muscles may twitch, and bleating is weak and tremulous. The wool becomes dry, lusterless, and dead to the touch. Ewes may abort, lambs may die at birth, and milk flow is reduced. As the disease progresses, there is evidence of slight incoordination when the animal moves, a tendency to stumble when it leaps too high to clear low objects, the gait is stilted, and the animal may have convulsive seizures after rough handling. Other symptoms are frequent dribbling of urine, periodic grinding of the teeth, and a tendency to stay away from the flock. There is some kind of impairment of the vision, evidenced by fixed and staring eyes, by movement of the eyeballs from side to side in some animals, and by instances of afflicted sheep colliding with things.

The animal may have a period of partial recovery, with a small gain in weight and improved vision, but it may also retain its excitability, scratch reflex, and lack of coordination, especially of the hind quarters. There is a gradual progression of partial paralysis, emaciation, prostration, perhaps linked with running movements of the feet, and death.

The course of the disease, from the earliest noted symptoms until death, may run from a few weeks to several months.

A detailed case history is that of an infected ram in California, which was observed weekly for more than a month:

May 9, 1955--Owner observes that ram is losing weight, though appetite continues good. After hoof trimming, animal seems to develop tremors and convulsive movements of hind quarters.

May 10--Blood-tinged discharge from both nostrils; temperature 102.4° F. [normal]; dribbling of urine; slight tremors of hind quarters; hind legs "wing out" when walking; some grinding of teeth; animal enjoys being scratched on hips, loins, and near tailhead, making chewing movements of lips.

May 16--Appetite good; possibly more excitable than a week ago; ears drooping; ram sways from side to side when moving head; head nods with movement of front feet; abnormal gait, weakness in hind quarters; no symptom of skin irritation causing rubbing, biting, or scratching, though some loose wool is noticed; after a short run, the ram is out of breath, pants with mouth open and tongue out; nasal discharge has decreased; when the animal rises after lying down, he has very poor coordination and frequently dribbles urine.

May 23--Ram is scratching and rubbing himself on the back, ribs, and rump; when his skin is scratched or pinched manually, especially on rump, he makes smacking and chewing movements of his lips, and is stimulated to ejaculation; he frequently attempts to mount ewes; central nervous system is deranged--he ran 100 yards in a ditch of water when he could have run on dry ground beside it; frequently squats or falls to the position for urination or somewhat to the right, then recovers without falling; is easily exhausted.

May 31--Temperature 105° F. [elevated, possibly from exertion]; slight loss of weight; nasal discharge more pronounced; less inclined to scratch himself, but manual pinching of rump elicits chewing movements and ejaculation; seems more dull, is easily exhausted, and urinates frequently; stands or lies down in the pasture every few minutes; runs into people, apparently through impaired vision or impaired response to things seen; waving objects before his eyes causes no excitement.

June 6--Ram is more alert, its sight has improved, and it has gained 2 or 3 pounds; more lack of coordination however--legs give way and he almost falls; a swollen gland under the lower jaw seems more nearly normal; right hind leg is swollen, but does not appear to hinder movement; acts more excitable when driven; owner says ram is rubbing and scratching more; scratch and ejaculatory reflexes easily elicited by pinching or rubbing skin or back, rump, or shoulders.

June 13--Greater lack of coordination, as ram falls to a squatting position and rises with difficulty; seems to start falling backward or to the side, then regains equilibrium and walks away; some weight loss; vision has deteriorated until objects and movements are apparently barely discernible; frequent dribbling urination continues; animal seems more easily exhausted; scratch and ejaculation reflexes still pronounced when skin is pinched; appetite still good; temperature 102.2° F. [normal]. Animal destroyed today for post-mortem examination.

Diagnosis.--The diagnosis of scrapie, a difficult matter, is based on both the observable symptoms and the laboratory findings. Normally, parts of the brain and upper spinal cord are examined for the presence of vacuoles, which are essentially tiny cavities or areas of vacuum within nerve cells. Laboratory confirmation of clinical diagnosis has rested largely on the finding of vacuoles. The vacuoles are of various sizes, usually sharply defined, either oval or round, and ranging from 1 to 6 in number in a single cell. Nerve cells show various degrees of displacement by vacuoles, depending on their size and number. Some cells may have only one small vacuole. Others may have several. Occasional cells have a single large vacuole in the center, surrounded by part of the cell's substance, giving it a signet-ring appearance. Some cells are obliterated by vacuoles.

How the disease causes these tiny areas of vacuum in the cells of the brain and spinal cord is not clear. Some investigators say that vacuoles can be found in perfectly healthy sheep, in older animals that have not had scrapie, and in sheep affected with other diseases. However, a series of experiments in Great Britain seems to validate the usefulness of vacuoles in diagnosis. Sixty sheep were inoculated with the organism that causes scrapie and 3 were killed each month; their brain tissue was examined for the existence of vacuoles. None were found until about 15 months after inoculation, when outward symptoms of scrapie had also appeared. The scientist in charge of this work finds that vacuoles are such a common result of scrapie that they can be found by examining from 1 to 6 sections of brain tissue, whereas it may require as many as 150 sections to find them in animals not afflicted with scrapie. Another British scientist, working with healthy goats, found only 8 nerve cells with vacuoles while examining 592 brain sections, whereas with scrapie-affected goats he discovered 2,279 cells with vacuoles in 94 sections examined. French investigators also say that vacuoles in brain tissue confirm a diagnosis of scrapie when considered with the readily observable outward symptoms.

Various other manifestations have been noted in the nerve cells examined for evidence of scrapie. They include swelling and inflammation of some cells.

Difficulties in diagnosing scrapie also arise from the fact that it may be confused with listeriosis, a bacterial disease of short duration that draws the head to one side and causes the animal to circle in one direction; with louping-ill, a virus disease affecting lambs and yearlings; with scabies, in which there is no lack of coordination and mites are the cause of itching; with Aujesky's disease or "mad itch," which runs a very short course of 1 or 2 days and is characterized by intense itching over a small area and by paralysis of the pharynx; with rabies, characterized by aggressive behavior and paralysis in the later stages but no itching; with cobalt deficiency, which causes dryness and loss of luster in the fleece; and with pregnancy toxemia at lambing time, caused by disordered metabolism. When scrapie is suspected the affected animals are held under observation to allow symptoms to become more pronounced. Such animals are not destroyed for laboratory examination until they are in the advanced stages of the disease.

Morbidity.--Incidence of the disease in European flocks may run as high as 20 to 30 percent. The highest known morbidity in the United States was in an Indiana flock, in which 10 percent of the animals became affected. It has not been possible to determine the average morbidity rate in the flocks in which the disease has been diagnosed in the United States because of the practice of slaughtering entire flocks in which one or more animals are known to be infected.

In the United States, of 126 confirmed cases, 121 were Suffolks and 5 were Cheviots. In Canada, confirmed cases have been found among Suffolks, Cheviots, and Hampshires. In Great Britain during recent years, more natural infection has been observed among Suffolks than in other breeds, but Cheviots are preferred as research animals. Border Leicesters are also frequently affected, and some cases have been reported among Swaledales and other breeds. Welsh Mountain sheep have never been known to be naturally infected, and the disease has occurred rarely in the Scottish Blackface breed. Reports from France indicate that the disease is not confined to any one French breed.

In the United States 97 ewes and 29 rams have been affected. Because of the normally greater number of ewes in a flock, it is felt that the disease has shown no significant differentiation in infecting males and females.

Mortality.--So far as is known, all animals affected with scrapie to the point of showing symptoms die of the disease. In France, where scrapie is not eradicated except by shepherds disposing of infected animals, the observation is that all those showing symptoms later die. In Great Britain, where similar practices are followed, however, some observers report rare cases of animals recovering from a disease believed to be scrapie. In countries where active eradication programs are in operation--Australia, Canada, New Zealand, the United States--the question cannot be tested because animals that do not soon die of the disease are slaughtered. In the state of present knowledge, it can be assumed that the disease is fatal in nearly all cases.

Transmission.--The means by which scrapie is spread are not well understood. There are indications that it may spread through breeding. One indication is that the progeny of infected animals often come down with the disease. In the United States, bloodlines are carefully traced after each new outbreak of scrapie; the relationships seem to be too striking to be coincidental. On the other hand, there are outstanding instances of rams that sired long lines of infected progeny yet never showed symptoms themselves. Two cases in point are those of Colony Ben and Badley Quinton. Colony Ben was born in England, exported to Canada, and had no less than 19 scrapie-infected off-spring in California and Illinois, yet is not known to have developed symptoms himself. Badley Quinton was also born in England and exported to Canada. He died when he was 8 years old without exhibiting symptoms of scrapie and a searching post-mortem revealed no sign of the disease. He was the grandsire of infected sheep in California, Indiana, Iowa, and Ohio, great-grandsire of infected sheep in Alabama and Texas, and great-great-grandsire of infected sheep in Missouri. Some British investigators doubt that the ram is very important in the transmission of scrapie.

British researchers exposed clean flocks to pasture previously occupied by scrapie-infected sheep, and the clean flocks eventually came down with the disease. This would seem to indicate that infected pastures spread the disease, but the same investigators now feel that the experiment should be repeated, to make certain that the "clean" animals had never been exposed to scrapie. The disease has been transmitted artifically--and accidentally--through vaccine for louping-ill, a virus disease that also affects the nervous system. The scrapie organism survived a rather heavy concentration of formalin used in the vaccine and caused outbreaks in most flocks in which the vaccine was used.

For purposes of research, brain emulsions of affected animals are injected into the brains of other animals to transmit the disease. British workers have injected material from sheep infected with scrapie into other sheep and have transmitted the disease through 16 serial passages. They have also transmitted the disease from sheep to goats and back to sheep and from artificially infected goats to other goats.

SPREAD OF THE DISEASE

SCRAPIE has been known to exist in Great Britain and Germany since about 1750 and in France since about 1850. Each of the three countries named it for a different symptom: the English scrapie for the itching and rubbing, the French tremblante for the tremors, and the German traberkrankheit, "staggering sickness," for the failure of coordination. It has also occurred in Austria, Hungary, and Poland. Early European accounts of the disease indicate that serious outbreaks not uncommonly forced flock owners out of business. The only method known of combating the illness was to dispose of the flock and later to replace it with disease-free animals.

First known occurrence in North America was in Ontario, Canada, in 1939, affecting a ewe imported with 12 others from Scotland the year before. Since then Canada has had additional outbreaks of scrapie--the latest in May 1957 in a flock of 55--and has followed the slaughter method of eradication.

Austrialia had an outbreak of scrapie in 1952 among sheep imported the year before from Great Britain. The imported flock was promptly slaughtered and further introduction of sheep from Great Britain was prohibited. New Zealand had an outbreak in 1952, traceable to animals from Great Britain, followed by a related occurrence in 1954. Infected and exposed sheep were slaughtered and further imports from Great Britain were stopped.

The disease was first reported in the United States in 1947, and by July 1957 it had appeared in 61 flocks in 19 widely distributed States--Alabama, California, Connecticut, Georgia, Illinois, Indiana, Iowa, Michigan, Missouri, New York, North Carolina, Ohio, Oregon, Tennessee, Texas, Utah, Virginia, West Virginia, and Wisconsin. The infected flocks have ranged in size from 4 sheep in Indiana to 14,250 sheep in California.

The disease was discovered in the 61 flocks by four principal groups of interested persons:

- By State and Federal inspectors on routine surveillance and engaged in tracing the movement of exposed animals, 49 percent (30 flocks).
- By practicing veterinarians, 23 percent (14 flocks).
- By sheep owners seeking assistance from regulatory officials, 15 percent (9 flocks).
- By veterinary institutions examining diseased sheep, 13 percent (8 flocks).

Owners have been quite cooperative in reporting evidence of disease in their sheep. A number of owners who had become familiar with the symptoms of scrapie as a result of veterinary inspections notified in-

spectors of suspicious symptoms or took their sheep to veterinary institutions.

A few examples of State experiences with scrapie illustrate the pattern of spread as it has unfolded in this country:

The first case diagnosed in the United States was observed in Michigan in April 1947, among animals of English stock imported from Canada. While on a trip to England a little later, the owner discussed scrapie with veterinarians, sheep owners, and shepherds. Acting on their advice, he slaughtered about 50 sheep in his flock having the same bloodline as the infected sheep. Since there was no recurrence of the disease in the meantime, he sold the remainder of his flock, about 65 animals, in 1950. Some of them, as a result of one or more sales, found their way into flocks in Indiana and Ohio.

California was the scene of the second scrapie outbreak, in the fall of 1952. The diseased animals had been purchased from another California flock, in which infected sheep were also found. Indications were that sheep in the second flock had received their infection through animals shipped from Ontario, Canada, from the same flock involved in the Michigan outbreak. California officials acted promptly to stamp out these outbreaks and to trace the possibility of further infection among 361 sheep sold into 53 other flocks in the State. Owners also marketed about 21,000 fat lambs for immediate slaughter.

California had another outbreak in May 1955, apparently introduced by sheep originating in Oregon. Thirteen sheep from the infected flock had been sold into four other flocks in the State. In the course of these outbreaks, all sheep sold into other flocks and their immediate progeny were eradicated.

Three more outbreaks occurred in California during the first half of 1957, involving larger flocks than had been affected by all previous outbreaks. The three flocks contained more than 18,500 animals. From two of the flocks there had been no sales except for slaughter, either within the State or outside it, but sales from the third have caused widespread concern. They included animals or their immediate progeny that went into about 150 other California flocks and to about 50 others in 14 States--Arizona, Colorado, Idaho, Illinois, Iowa, Missouri, Nevada, Oklahoma, Oregon, Texas, Utah, Virgina, Washington, and Wyoming. An infected ewe in this flock was sired by a ram that was the grandsire of an infected ewe in Utah. Grandsire of the California ewe was Badley Quinton, whose progeny included a number of scrapie-infected animals (page 7).

Ohio was the third State in which the disease was diagnosed. Animals in the infected flock had been purchased from a flock in Canada, the same from which sheep had been sold into the infected Michigan flock and was involved with the first infected flocks in California. Eighty-seven sheep from this flock were sold into 43 flocks in Ohio and 25 were sold into 6 flocks in Indiana, Kentucky, Pennsylvania, and Tennessee. Three outbreaks in Ohio and two in Tennessee were later attributed to sales from this flock. Altogether, Ohio has had 9 outbreaks of scrapie in as many flocks and counties, with 948 sheep affected or exposed. The latest was in June 1956, in a flock of Cheviots, foundation animals of which had been purchased in 1953 from an Ohio breeder whose flock was slaughtered in 1955 because of scrapie infection.

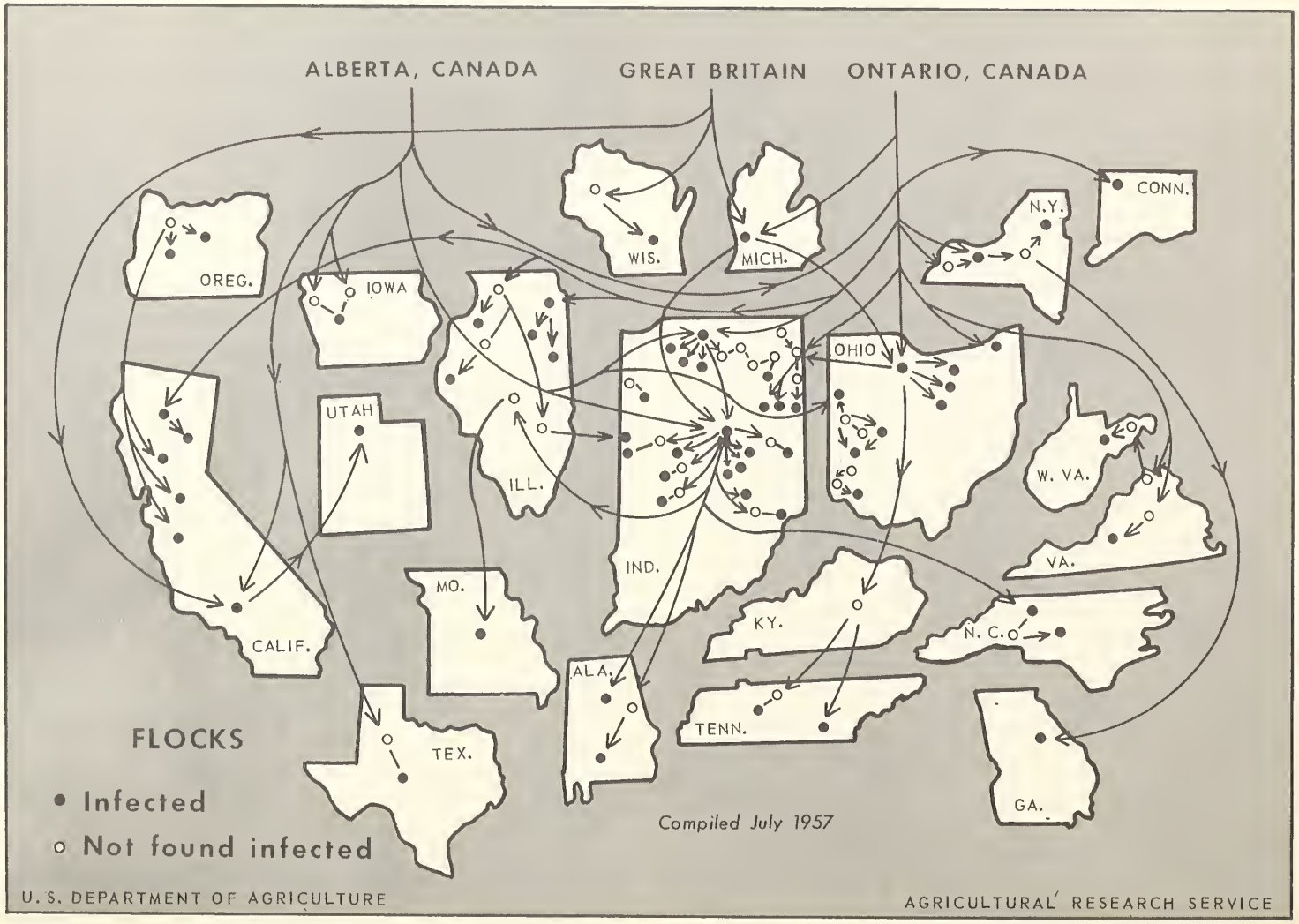

Figure 3.--Routes by which scrapie may have spread in the United States, 1947-57.

Scrapie has hit Indiana more often than any other State. It has had 21 outbreaks in flocks totaling 1,067 animals. In spite of the caution exercised by Indiana authorities in the fall of 1952, when they traced and slaughtered 11 sheep that had been sold into 6 flocks from an infected flock in Illinois, scrapie struck within the State in August 1954. One year and 9 outbreaks later, a flock that had been the source of many outbreaks had one of its own. Sheep had been bought from many sources, and it is not easy to pin down the places from which the infection came. Apparently it entered Indiana from the north, possibly through flocks in Alberta or Ontario, Canada, or perhaps through the infected flock in Michigan, from all of which purchases had been made.

Sales from this Indiana flock were more widespread than purchases. In fact, they afford a classic example of the way disease can be spread and animals can be exposed through commercial transactions. A total of 128 sheep were sold into 42 Indiana flocks; among these flocks there have been 9 outbreaks of scrapie traceable to animals or their progeny sold by this breeder. Outside Indiana, 194 sheep from this flock were sold (or resold) into 43 flocks in 13 States--Alabama, Connecticut, Florida, Illinois, Iowa, Kansas, Kentucky, Mississippi, Missouri, North Carolina, Ohio, Tennessee, and Wisconsin. Outbreaks of scrapie traceable to this source have occurred in Alabama, Missouri, and North Carolina. Representative figures show that 23 animals sold into 10 flocks in 3 States exposed a total of 882 sheep to scrapie.

From 8 other Indiana flocks in which scrapie appeared, 177 sheep were sold or loaned into 58 flocks within the State and 6 sheep were sold into 4 flocks in Illinois. Five outbreaks of scrapie in Indiana are apparently traceable to these sales.

Indiana has had 3 outbreaks in 1957. In one of these, the infected ewe was the progeny of a dam previously exposed to scrapie and slaughtered as an exposed animal, but her lamb (the infected ewe) was not slaughtered. Her grandsire was the grandsire of another infected ewe in Indiana, sire of 2 infected ewes and an infected ram in Indiana, of 2 infected rams in Missouri, and of 1 infected ram each in Alabama and North Carolina.

The experience of these and other States affected with scrapie is outlined statistically in table 1 and graphically in figure 3.

Chronologically, the outbreaks have appeared in the following order (by calendar years): 1947--1 (Michigan). 1952--4 (California, Ohio). 1953--6 (Illinois, Ohio). 1954--8 (Connecticut, Illinois, Indiana, New York, Ohio, Oregon). 1955--23 (California, Georgia, Indiana, Iowa, Missouri, North Carolina, Ohio, Tennessee, Texas). 1956--10 (Alabama, Illinois, Indiana, North Carolina, Ohio, Virginia, Wisconsin). 1957 (through July)--9 (Alabama, California, Indiana, Utah, West Virginia).

RESEARCH

RESEARCH on scrapie is time-consuming and costly: it requires time to span the long incubation period, large numbers of animals to get the required number of "takes" in artificial inoculation, space in which to maintain and segregate flocks used in experimentation, space and maintenance for the flock increase. A deterrent to the investigation of scrapie in this country has been the lack of facilities available for such research.

Table 1.--Outbreaks of scrapie in the United States, April 1947-July 1957

State	First outbreak reported	Outbreaks to date	Known movement of animals through sales before identification of disease		Possible source of original infection
			Intrastate	Interstate	
	Date	*Number*	*Number*	*Number*	
Alabama	4/56	2	14	--	Indiana
California	1/52	6	[1] 524	[2] 50	Canada, Oregon
Connecticut	12/53	1	15	1	Canada
Georgia	5/55	1	25	16	New York, Canada
Illinois	10/52	5	242	16	Canada
Indiana	10/52	21	321	200	Canada, Michigan
Iowa	7/55	1	17	--	Canada
Michigan	4/47	1	?*	?*	Canada, England
Missouri	11/55	1	--	--	Indiana
New York	7/53	2	30	3	Canada
North Carolina	10/55	2	7	1	Indiana
Ohio	12/52	9	87	25	Canada, Michigan
Oregon	11/54	2	8	1	England, Canada
Tennessee	4/54	2	214	--	Ohio, Canada
Texas	1/55	1	?*	--	Canada
Utah	2/57	1	--	--	Calif., Can., Eng.
Virginia	12/55	1	100	79	Canada
West Virginia	7/57	1	--	--	Virginia, Canada
Wisconsin	4/56	1	--	--	Canada, England
Totals		61	1,454	342	

*Unknown.
[1]Of this number, sales were made into 150 flocks, number of animals and their progeny not available.
[2]Sales from 1 California flock were made into about 50 flocks in 14 States. Number of animals and their progeny not known.

The time-consuming nature of research with scrapie is evident from European experience with the disease: Animals having the virus injected directly into the brain required 4 to 22 months to come down with the disease. Animals inoculated with a vaccine contaminated with the causative organism took 1-1/2 to 2 years to show symptoms. An experiment with infected pasture was started in Great Britain in 1932 and it was 1936 before the disease appeared in any of the animals.

Long-term basic research may be required to learn whether, as suspected, some animals contract the disease and show atypical symptoms, whether some may have inapparent cases, whether some may be symptomless carriers and spreaders of the disease.

No research is being carried on in France, but active research is being done in Canada and Great Britain.

In Canada, as elsewhere, a great need is felt for a reliable test that will show whether an animal is infected before it begins to show symptoms. Canada is examining the blood of animals at various stages of infection, searching for antibodies. If antibodies can be isolated, they may be used in blood tests, and it may be possible to detect scrapie-infected animals well ahead of the appearance of symptoms, to point out inapparent cases (of infected animals that never show symptoms), and possibly those that may carry and spread the disease.

Canadian scientists are working on the problem of propagating the scrapie organisms through tissue culture. They are attempting to seed the organism on growing sheep kidney. An attempt is being made to combine this work with the search for antibodies, with the hope that test-tube proof of the disease in its early stages can be worked out, thereby subtracting from the problem much of its extended time element.

As another approach, Canadians are attempting to propagate the disease on the embryonic skin of sheep and in male and female genital tracts. In following through with live animals, researchers hope to learn whether

the disease colonizes in the genital tract and discover if possible whether it is propagated by breeding.

Canada is also investigating the possibility that keds, or sheep ticks, might spread the disease. Observation in the United States is that the disease is not seasonal, as would probably be the case if it were insect- or arthropod-borne.

In Great Britain, interest has been revived in scrapie research because of occurrence of the disease through vaccination for louping-ill and because of its spread into Canada, the United States, Australia, and New Zealand, resulting in cessation of British exports of sheep to these countries. Many avenues of research are being followed, with more than 2,000 sheep and goats being used in the experiments. Efforts are being continued to identify the agent that causes the disease. Studies include physical and chemical characteristics of the causative agent and its resistance to heat, disinfectants, chemicals, and drugs. Attempts are being made to grow the agent of scrapie on various tissues, in eggs, and in chick embryos. The search for antibodies continues, though efforts to find this diagnostic aid have failed thus far. Effects of the disease are being studied and restudied, especially those on the nervous and muscular systems, the skin, and the occurrence of vacuoles in the central nervous system. Methods of spread are being investigated, including contact exposure, indirect exposure, exposure by mating, and genetic transmission. The relative susceptibility of different breeds of sheep is being studied in 25 of the more important breeds of sheep in the United Kingdom. British scientists have tried to infect small laboratory animals with scrapie, but the efforts have been uniformly unsuccessful. The search continues for susceptible small animals.

The Agricultural Research Service is cooperating with Great Britain in research on scrapie.

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